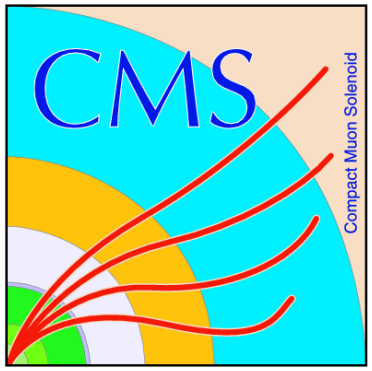
Baseline energy calibration

with v5 geometry



P. Silva (CERN)

Friday, 24th October 2014

Material overburden for v5

Sub-detector	Layer	Material overburden before sensitive detector						Total X_0	ΣX_0	Total λ	Σ λ
		Al [mm]	Cu [mm]	Pb [mm]	W [mm]	Steel [mm]	Brass [mm]				
EE	1	4	0.5					0.08		0.01	
	2		3.5	1	1.75			0.92		0.05	
	3		6	1				0.60		0.04	
	4		1		1.75			0.57		0.02	
	5		6	1				0.60		0.04	
	6		1		1.75			0.57		0.02	
	7		6	1				0.60		0.04	
	8		1		1.75			0.57		0.02	
	9		6	1				0.60		0.04	
	10		1		1.75			0.57		0.02	
	11		6	1				0.60		0.04	
	12		1		2.8			0.87		0.03	
	13		6	2.1				0.79		0.05	
	14		1		2.8			0.87		0.03	
	15		6	2.1				0.79		0.05	
	16		1		2.8			0.87		0.03	
	17		6	2.1				0.79		0.05	
	18		1		2.8			0.87		0.03	
	19		6	2.1				0.79		0.05	
	20		1		2.8			0.87		0.03	
	21		6	2.1				0.79		0.05	
	22		1		4.2			1.27		0.05	
	23		6	4.4				1.20		0.06	
	24		1		4.2			1.27		0.05	
	25		6	4.4				1.20		0.06	
	26		1		4.2			1.27		0.05	
	27		6	4.4				1.20		0.06	
	28		1		4.2			1.27		0.05	
	29		6	4.4				1.20		0.06	
	30		1		4.2			1.27	25.7	0.05	1.31
HEF	31		0.5			15	40	3.58		0.34	
	32-42		0.5				40	2.72	30.0	0.25	2.73
HEB	43-54						34.5	2.31	27.7	0.21	2.53
Total									**83.41**		**6.57**

Proposed grouping

- 1
- 2-10
- 11-20
- 21-30
- HEF 1
- HEF 2-12
- HEB 1-12

Energy weights

- Compare three different weight sets to be used as baseline energy estimation
  - Trivial weights : all weights set to 1
  - Radiation or nuclear interaction-based weights

$$\hat{E} = \sum_{i=1}^{N_{\text{layers}}} (X_{0,i} \; or \; \lambda_i) \cdot E_i$$

  - Optimized weights from linear regression using all generated events

$$\Delta^2 = \sum_{n=1}^{N_{\text{events}}} \left[\sum_{i=1}^{N_{\text{layers}}} w_i \cdot \frac{E_{i,n}}{E_n^{\text{gen}}} - 1 \right]^2$$

- For each set of weights derive calibration curve separately
  - trivial calibration is expected for the optimized weight set

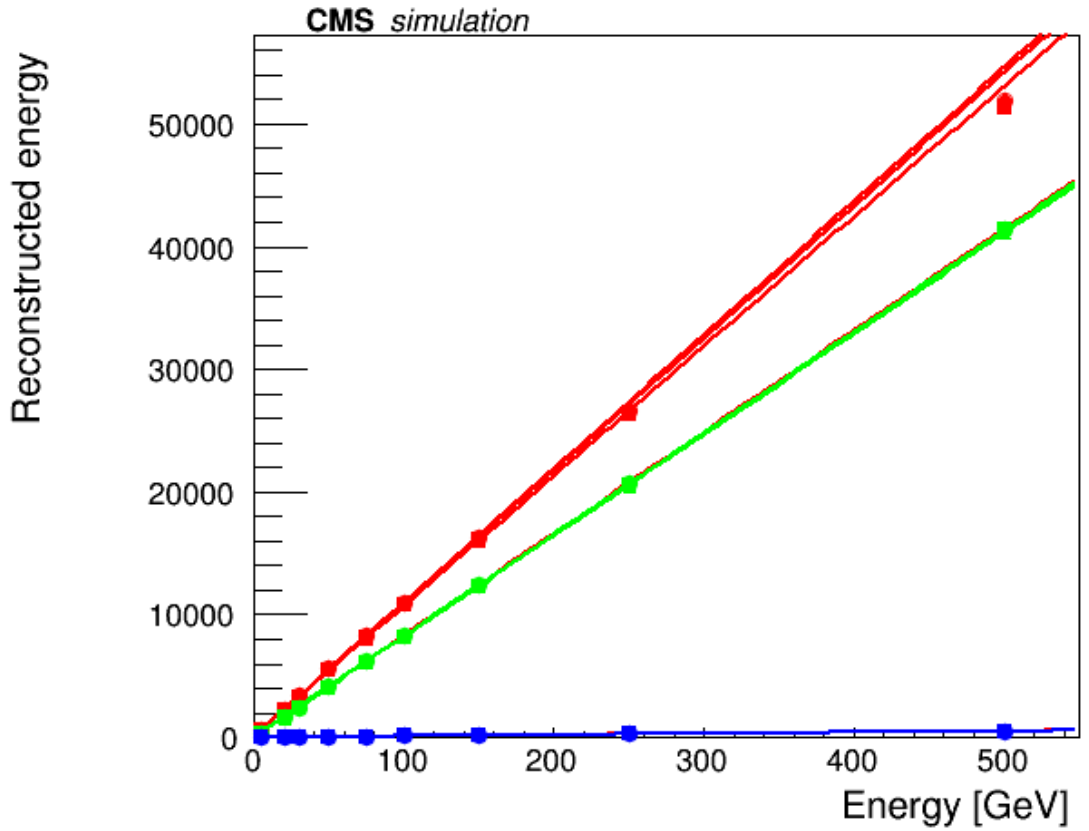
Photon energy calibration

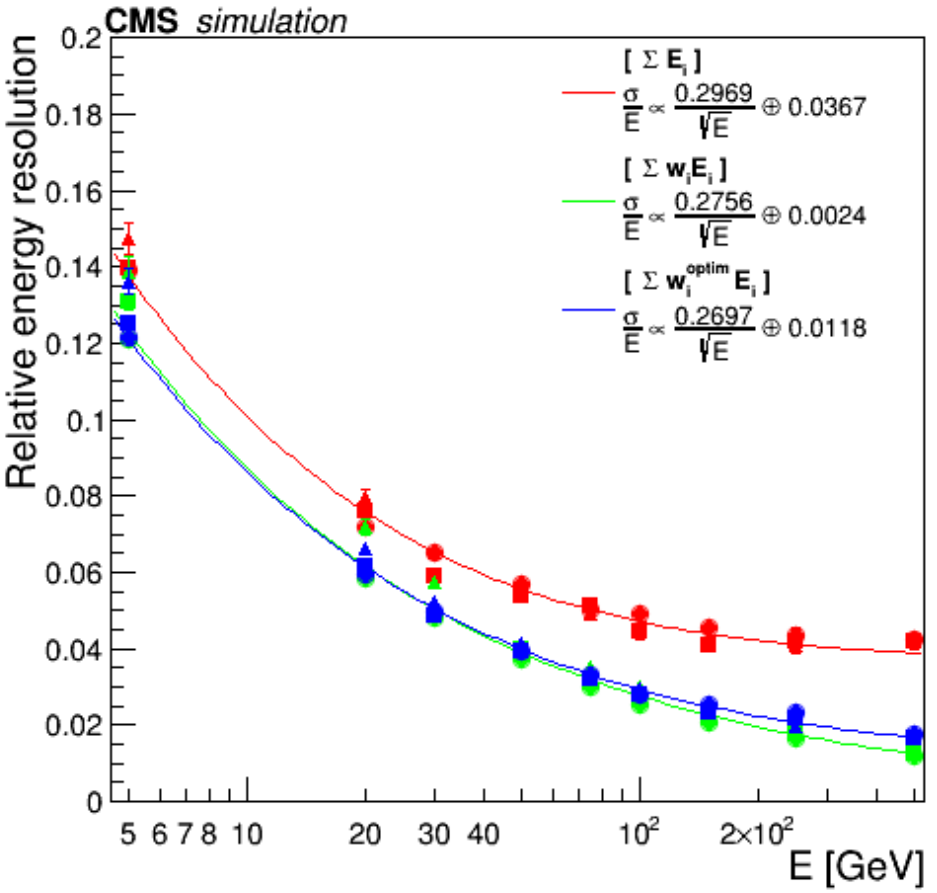
Trivial weights $\hat{E} = 108.9 \times E_{beam} + 36.2$ | $\hat{E} = 108.1 \times E_{beam} + 23.4$ | $\hat{E} = 105.7 \times E_{beam} + 106.2$

X_0 weights $\hat{E} = 82.8 \times E_{beam} + -28.6$ | $\hat{E} = 82.5 \times E_{beam} + -37.7$ | $\hat{E} = 82.2 \times E_{beam} + -69.0$

Optim weights $\hat{E} = 1.0 \times E_{beam} + 0.0$ | $\hat{E} = 1.0 \times E_{beam} + -0.1$ | $\hat{E} = 1.0 \times E_{beam} + -0.4$

- Minor impact from optimization
- Propose to use X_0-based weights





Pion energy calibration

Trivial weights

$[\Sigma E_i, 1.5<\eta<2.0]$ $\hat{E} = 49.6 \times E_{beam} + 54.5$

$[\Sigma E_i, 2.0<\eta<2.5]$ $\hat{E} = 47.4 \times E_{beam} + 67.8$

$[\Sigma E_i, 2.5<\eta<2.9]$ $\hat{E} = 50.0 \times E_{beam} + 23.3$

λ weights

$[\Sigma w_i E_i, 1.5<\eta<2.0]$ $\hat{E} = 4.1 \times E_{beam} + -9.8$

$[\Sigma w_i E_i, 2.0<\eta<2.5]$ $\hat{E} = 4.1 \times E_{beam} + -7.5$

$[\Sigma w_i E_i, 2.5<\eta<2.9]$ $\hat{E} = 3.9 \times E_{beam} + -3.7$

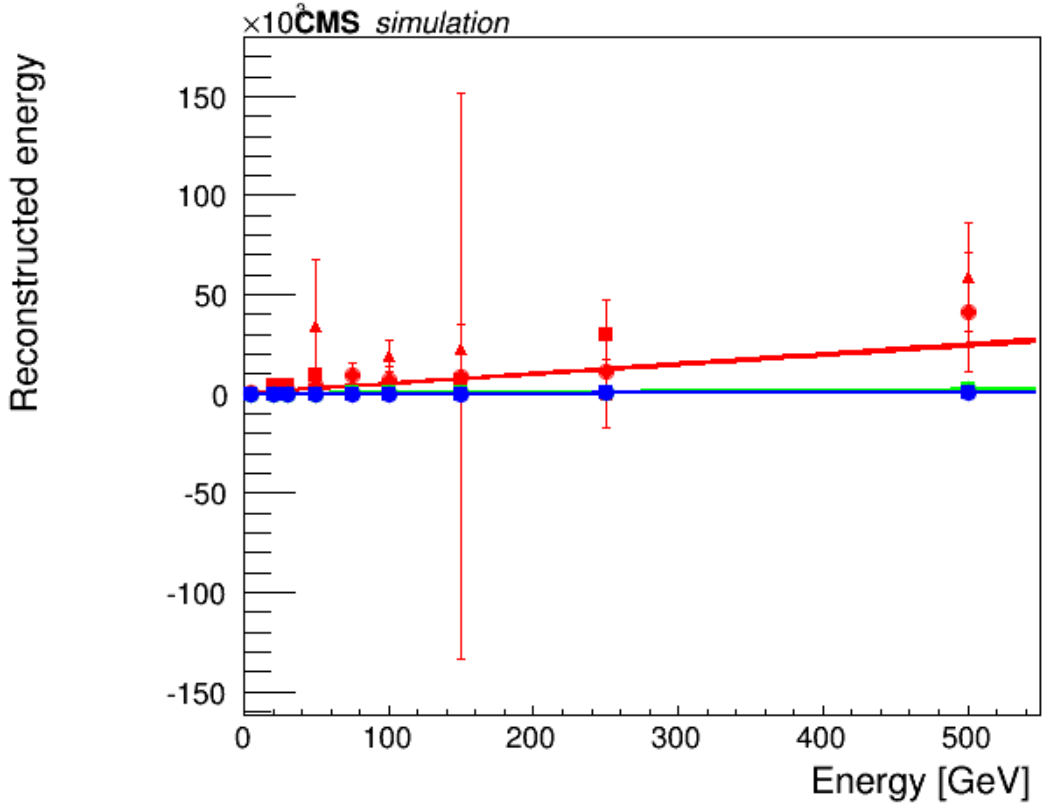
Optim weights

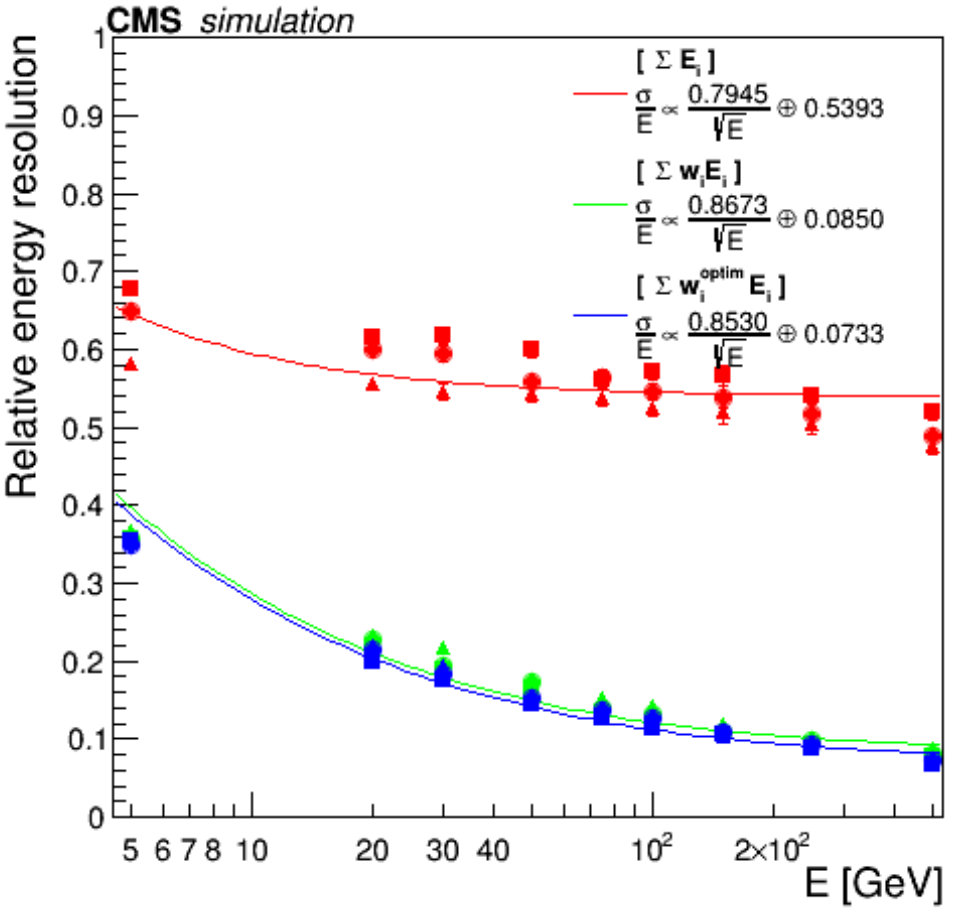
$[\Sigma w_i^{optim} E_i, 1.5<\eta<2.0]$ $\hat{E} = 1.0 \times E_{beam} + -1.0$

$[\Sigma w_i^{optim} E_i, 2.0<\eta<2.5]$ $\hat{E} = 1.0 \times E_{beam} + -1.4$

$[\Sigma w_i^{optim} E_i, 2.5<\eta<2.9]$ $\hat{E} = 1.0 \times E_{beam} + -1.7$

- Small impact from optimization
- Propose to use optimized weights





Conclusions

- Propose to use as a start the following weights for e.m. and hadronic reconstruction

Calibration	Weights	Layer 1	2-11	12-21	22-30	31	32-42	43-54
e.m.	X0-based	0.0800	0.6200	0.8100	1.1900	3.5800	2.7200	2.3100
	Optimized	0.0483	0.0080	0.0096	0.0156	0.0754	0.0876	0.1462
hadronic	λ-based	0.0100	0.0360	0.0420	0.0550	0.3400	0.2500	0.2100
	Optimized	0.0179	0.0105	0.0096	0.0169	0.0464	0.0474	0.1215

Calibration	W/W_{2-11}	Layer 1	2-11	12-21	22-30	31	32-42	43-54
e.m.	X0-based	0.1	1.0	1.3	1.9	5.8	4.4	3.7
	Optimized	6.0	1.0	1.2	1.9	9.4	11.0	18.3
hadronic	λ-based	0.3	1.0	1.2	1.5	9.4	6.9	5.8
	Optimized	1.7	1.0	0.9	1.6	4.4	4.5	11.6

- The code used to derive these curves is described in

  https://twiki.cern.ch/twiki/bin/view/CMS/HGCalUserCodeHGCanalysis#SimHit_based_calibration

- Next proposed steps
  - check these calibrations hold at RecHit and cluster level
  - Can use the SimHit code as starting point?
  - improve with compensation schemes or regression